RESEEDING

TO INCREASE THE YIELD OF MONTANA RANGE LANDS

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WAR DEMANDS ON WESTERN RANGE lands have intensified a major problem confronting the livestock industry in Montana—the great need for more and better range. Additional range forage is imperatively needed to meet emergency demands for production of beef, lamb, wool, and hides. Today several million acres of range lands are yielding only a small fraction of the forage they should produce. A considerable portion of the best of these low-productive lands consists of areas that have been plowed, used briefly for farm crops, and then abandoned. Three-fourths of this plowed land is not coming back satisfactorily to forage plants, and much of it is deteriorating through wind erosion. Cannot some of these areas be restored to greater usefulness? Tests by the Forest Service and other agencies have shown that many of them could be brought back quickly to better forage through artificial reseeding. By inexpensive methods, it is usually possible to double or even quadruple the grazing capacity of the lands within 2 to 4 years.

To safeguard against costly mistakes, however, and to insure reasonable and early results in reseeding at moderate expense, certain rules should be observed. The guides herein outlined as to where, what, when, and how to reseed, based on experience and research, supply this essential information for those Montana ranchers who contemplate increasing their forage supply. They may also be helpful on other western ranges.

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COVER PHOTOGRAPH.—Formerly plowed range restored to high grazing capacity by reseeding to crested wheatgrass. (F418361.)

RESEEDING TO INCREASE THE YIELD OF MONTANA RANGE LANDS

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INTRODUCTION

REGRASSING nonproductive range lands in Montana, especially the extensive abandoned areas on which the original sod was destroyed by attempts to use them as croplands, is urgent in view of present emergency demands for livestock production. Restoration of these lands is also important to the prosperity of the livestock industry and even more so to the economic welfare of the State. Over half of the gross agricultural income from 93 million acres is derived from the livestock industry, which in turn depends largely upon, and at present lacks a sufficient supply of, the cheap range forage required to support more than a million beef cattle, more than 4 million sheep, and a quarter of a million horses.

In the decades from 1900 to 1940, during periods when wheat prices were generally favorable, about 4 million acres of ill-spared range land submarginal for wheat was plowed and put into wheat. More recently, chiefly because of the hazard of recurring drought, these attempts have failed, and wholesale land abandonment, with its accompanying social and economic ills, has followed (fig. 1). The forage-plant cover has been restored on perhaps as many as 1 million of these plowed acres through artificial and natural reseeding, but approximately 3 million acres remain unproductive. Revegetation by natural processes is in most cases extremely slow, ordinarily requiring 20 to 50 years. The period varies with such factors as degree of soil and plant depletion, available moisture, and intensity

[1] Certain phases of the station's research in artificial range revegetation are conducted in cooperation with the Montana Agricultural Experiment Station and the Bureau of Animal Industry, Department of Agriculture, at the U. S. Range Livestock Experiment Station near Miles City, Mont. Other phases, conducted elsewhere, are in cooperation with the Montana station and the Bureau of Plant Industry.

and season of use by livestock. No cure-all for the recovery of these ranges appears, but a remedy that in many instances will bring about increased forage yields is artificial reseeding, if carefully conducted.

Unplowed range lands with a low level of production constitute a problem of major importance. Can they be improved by reseeding? Frequently they can, though procedures have not yet been worked out for all cases. Of the several million acres of range lands in this condition, reseeding by present procedures is justified on roughly 750,000 acres, where depletion is severe (fig. 2), including areas that have been burned, heavily grazed, logged, or otherwise disturbed. The remainder can probably be restored through good management devoted to increasing the stand of native forage plants.

That artificial range reseeding is practicable has been repeatedly demonstrated by the Northern Rocky Mountain Forest and Range Experiment Station since 1933, through experiments on more than 1,700 acres of range lands in 27 Montana counties. The results have been confirmed by studies of the Montana Agricultural Experiment Station, by the reseeding programs conducted by the national-forest administration and by the Soil Conservation Service, and by the plantings made by hundreds of ranchers, largely in connection with Agricultural Adjustment Administration range-improvement programs. In all, more than 320,000 acres of range lands in Montana have been reseeded during the past 5 years, but this is only some 10 percent of the area in urgent need of revegetation. The results have been excellent, but the rate of reseeding must be increased manyfold if the needs of the present and immediate future are to be met.

The application of artificial revegetation is limited by costs and returns. Since the value per acre of the forage produced on most range lands is low, even under the best possible management, large expenditures for planting are seldom justified. Consequently, inexpensive methods are stressed in this bulletin. It should be borne in mind that while recommendations are based on tests made under a wide variety of conditions in Montana, they may not be wholly applicable in other regions.

BEST CONDITIONS FOR SOWING

The most favorable range conditions for reseeding are ample soil moisture, level or gently sloping topography, deep, fertile soil, and a sparse vegetation cover. Contrariwise, on range lands where soil moisture is extremely meager, the slopes steep, the soil very rocky and thin, or the stand of existing vegetation too dense, sowing may not be profitable.

The western third of Montana is characterized by rugged mountains, foothills, and intermountain valleys at elevations varying from 2,000 to 12,800 feet. These are in sharp contrast to the gently rolling plains occupying nearly all of the remainder of the State, which extend from the eastern flank of the Rocky Mountains to the Dakotas and lie chiefly below the 4,000-foot contour. Chiefly as a result of these variations in topography, as well as in soils and climate, the native range vegetation of the western third of the State is distinct from that of the middle and eastern parts. The mountains are largely forested, and in the foothills and intermountain valleys the trees are interspersed with bunchgrass and some sagebrush. Forage

plants in the western mountains are of the Pacific bunchgrass type, including such species as Idaho fescue [2] and bluebunch wheatgrass. On the short-grass plains to the east of the mountains the principal kinds of cover are grass or sagebrush and grass, blue grama and

FIGURE 1.—*A*, Reseeding is needed on hundreds of similar abandoned dry farms to replace weeds and cheatgrass with a dependable grass cover. *B*, In eastern Montana many such weed-covered, formerly plowed range lands have been successfully reseeded to forage species.

bluestem or "western" wheatgrass being two of the most important native species. In some of the foothills and isolated mountains, such as the Bear Paws section of the north central part of the State, range conditions are intermediate.

CLIMATE

Partly because of the range in altitude but also because of the barrier formed by the Rocky Mountains, there is a considerable difference in climate between Montana's two major topographical divisions.

[2] A list of common and botanical names of plants mentioned in this bulletin appears on p. 25.

For example, in the mountains, foothills, and valleys, 40 to 65 percent of the total annual precipitation falls during the 6 summer months, while 70 to 80 percent falls during the same period throughout most of the plains. The average annual precipitation is 15 to 30 inches in the mountains, 11 to 18 inches in the intermountain valleys, and 11 to 15 inches on the plains. Summer temperatures average somewhat higher on the plains than in the mountains, foothills, and valleys, particularly at night. On the other hand, average winter temperatures are lowest on the plains. Average wind velocities during the growing season are greater on the plains than in the mountains.

Climatic extremes in Montana do not generally prevent successful reseeding of ranges, though failures attributable to climate may be frequent in some localities. Fortunately, grass seedlings of most species are able to stand great variations in temperature. While it is probable that sudden occurrence of very low temperatures occasionally kills seedlings of even the native grasses, a more serious hazard is a week or two of dry weather, accompanied by high temperatures and winds. Such conditions may prove dangerous to tender seedlings of the most drought-resistant species.

Though even less predictable, favorable distribution of rainfall and snowfall during the year is far more important for success than total precipitation. Indeed, reseeding has been successful on some areas that received less than 10 inches of precipitation in the 12 months that followed. A good example is a formerly plowed range area on the McCollum ranch near Ingomar, Rosebud County, that was reseeded in November 1933. Here the total precipitation was 4.29, 10.41, and 4.89 inches in 1934, 1935, and 1936, respectively; yet in spite of this extreme drought the area bore a good, thrifty stand of grass at the close of the third year.

Other things being equal, reseeding is most likely to succeed on sites where climatic conditions are least likely to prove extreme—on flats or gentle slopes where run-off from sudden showers is not excessive, in contrast to steep, sunny, windswept slopes that are subject to heavy run-off, abnormal erosion, and rapid drying. This does not mean that reseeding will necessarily fail on sites of the latter type, but rather implies that there is a greater possibility of having to reseed them more than once to obtain a satisfactory stand of grass.

SOIL

The soils characteristic of Montana range lands vary from sandy to heavy clays, including raw subsoils and types containing some alkali. Fortunately, a few forage plants will grow fairly well on any of these soils.

Crested wheatgrass, for example, is making a creditable showing in competition with alkali-tolerant inland saltgrass at the U. S. Range Livestock Experiment Station near Miles City, Mont., and on the Larson ranch in Garfield County. On the Hurtt ranch in Missoula County it is doing well even on subsoil with a southern exposure, the location being a borrow pit from which 5 feet or more of the topsoil was removed. Equally adverse conditions on road grades in Beaverhead County have not prevented its growth. Crested wheatgrass appears thrifty also on spots where brush was burned from

clearings in Mineral, Sanders, and Ravalli Counties. Sweetclover occurs commonly throughout the State, indicating its ability to grow on a variety of soils. Smooth brome is likewise adapted to a number of different sites, although it is less tolerant of a dry climate. In general, therefore, it is possible to grow certain forage species on the soils of all formerly plowed lands, as well as on most depleted range lands.

COMPETITION FOR SOIL MOISTURE

Other things being equal, the chances for success in regrassing range lands increase materially as competition for soil moisture by existing perennial vegetation decreases. It has been observed that competition

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FIGURE 2.—On depleted mountain parks such as this, reseeding by inexpensive methods often pays good dividends.

is likely to prevent the establishment of seedlings of the grasses artificially sown in bunchgrass range when more than 15 percent of the soil surface is covered with perennial vegetation, and in range characterized by sod-forming grasses when 7 percent of the soil is so covered. If the ground cover includes a fair proportion of desirable grasses, reseeding is seldom justified. If reseeding is attempted under such conditions, disking or other means of partially destroying the competing vegetation is usually essential. The degree of competition that can be tolerated varies with soil and exposure, available soil moisture, and the kind of plants occupying the area. It follows that, on a given range, the maximum allowable density is lower on a dry, infertile site than on a moist, fertile one.

Cheatgrass brome (commonly called cheatgrass and known also as downy chess) occupies thousands of acres of range land in Montana and presents a special problem. Winter annuals of this sort commonly germinate and begin growth in the fall, become dormant during the winter, resume growth early the following spring, and complete their life cycle by July. Consequently they compete severely

with young grass seedlings for soil moisture during the critical spring period.

Results to date do not encourage extensive plantings in thick stands of cheatgrass without provision for reducing competition. Where scattered perennial grasses are beginning to appear in such stands, management favoring the better grasses will frequently restore forage production to a satisfactory level. Areas of this kind should not ordinarily be considered as being in great need of reseeding. After a dry fall cheatgrass is usually reduced in density, and fair stands of perennial grasses have been obtained by sowing an unprepared seedbed very late in such a season or early the following spring.

On the other hand, late-developing annuals, such as tumbling Russian-thistle, seldom compete severely with grass seedlings from fall or even early spring plantings. One reason is that such weeds usually germinate in the spring and develop rather slowly until June, offering little competition for moisture during much of the critical early period in the life of grass seedlings. Numerous tests have demonstrated that it is practicable to grow satisfactory stands of grass among Russian-thistle by merely drilling the seed on an unprepared seedbed.

WHAT TO SOW

To be of general value for range reseeding, a forage species must be adapted to the site and be able to endure drought and cold; it must be relatively easy to establish, a fair producer, palatable, and able to withstand at least moderate grazing; it must be able to maintain itself for a number of years; and the seed must be reasonable in price. If possible, seed grown in the same locality or in one having a similar climate should be obtained. Table 1 lists the more promising species, as well as the particular conditions under which these recommended species may be sown advantageously.

Adaptability to climate, topography, and soils should be carefully weighed in selecting the species for reseeding a specific area. Only a few forage species are so widely adaptable that they can be used to advantage on both plains and mountain range lands. Crested wheatgrass, smooth brome, and yellow sweetclover are such exceptions; they have succeeded on mountain as well as on plains ranges. These three plants will therefore be discussed first.

CRESTED WHEATGRASS

Crested wheatgrass has been more successful than any other grass extensively tested to date throughout the State, proving well adapted to a wide variety of well-drained soils on the plains of the east and the valleys, foothills, and mountains of the west up to elevations of 6,500 to 7,500 feet. Excellent stands have been obtained on depleted range up to 7,000 feet. Above this elevation, although test plantings on thin soil at 8,600 feet have produced viable seed, a few other species appear more promising.

In spite of extreme drought and heavy grasshopper infestations, experimental plantings of crested wheatgrass, totaling more than 900 acres in all, were completely or potentially successful under a wide range of conditions. Most of these plantings were made on formerly plowed foothill and plains ranges during the period 1934–36, begin-

TABLE 1.—*Range-forage species for reseeding depleted and formerly plowed range lands in Montana, with sowing recommendations*

Species	Description	Where to sow	Rate to sow per acre	
			Drilled	Broadcast
			Pounds	*Pounds*
Blue grama	Hardy, drought-resistant, highly palatable, native perennial grass, with spreading fibrous roots. Under favorable conditions forms a sod. Somewhat difficult to establish.	Best suited to the plains ranges. Not known to occur naturally west of Continental Divide in Montana.	5–7	6–8
Bluestem wheatgrass.	Long-lived native perennial grass that forms vigorous underground rootstocks; highly palatable. A rather poor seed producer and somewhat difficult to establish.	Does best on plains ranges, particularly in places where runoff waters accumulate. Prefers the heavier soils.	6–8	8–10
Crested wheatgrass.	Hardy, drought-resistant, long-lived perennial bunchgrass; grows best in cool weather. Easy to establish and a prolific seeder. Especially good for spring grazing. Widely adapted; is the outstanding species for range reseeding in Montana.	Depleted and formerly plowed range lands of the plains, valleys, foothills, and mountains up to at least 7,000 feet elevation throughout Montana. Good choice for dry sites.	3–5	4–6
Indian ricegrass.	Long-lived, densely tufted, native perennial bunchgrass, with deep, fibrous roots. Seed may fail to germinate during the first growing season. Moderately palatable.	Depleted ranges in mountains and foothills, at elevations up to 6,500 feet, or greater. Occurs naturally on sunny exposures, especially on light or sandy soils.	5–7	6–8
Ladak alfalfa	Moderately long-lived, deep-rooted, drought-resistant perennial legume. Highly palatable and a good soil builder. Best used in mixture with one or more grasses.	Formerly plowed plains and foothill range lands in swales or in localities where moisture is above average. Difficult to establish on driest sites.	3–5	4–6
Mountain brome.	Robust, short-lived, perennial bunchgrass with deep, fibrous roots. Reproduces by seed only. All livestock relish early growth and large seed heads.	Depleted mountain range lands at medium and high elevations, particularly where the subsoil is exposed.	8–10	10–12
Orchardgrass	Long-lived, highly palatable perennial bunchgrass with deep, fibrous roots; moderate drought-resistant. Tolerates some shade.	Does well where better-than-average moisture conditions prevail on depleted mountain ranges and in intermountain valleys.	4–6	5–7
Smooth brome	Long-lived perennial sod former; spreads chiefly by underground rootstocks. Of high grazing value and relatively easy to establish except in drought years. Once established, it endures cold and drought well.	Best used on depleted mountain ranges (except on lower, drier slopes) and on formerly plowed plains ranges where rainfall is not too scanty. Does well in swales in eastern Montana.	6–8	8–10
Tall oatgrass	Deep-rooted, moderately long-lived, robust, perennial bunchgrass; produces large amount of forage. Seed sown more easily if mixed with other species, or de-awned.	Depleted mountain ranges, especially at medium and high elevations. Does best on the moister sites.	5–7	6–8
Timothy	Hardy perennial with fibrous roots; reproduces only by seed. Produces large volume of excellent forage on moist soils. Best used in a mixture.	Does well in the mountains where soil moisture is favorable. Should not be used on the drier ranges of the plains.	3–4	4–6
Yellow sweetclover.	Deep-rooted biennial legume, moderately palatable until midsummer; a good soil builder. Serves as a nurse crop for grass seedlings; best used in a mixture.	Does best on plains ranges but is well suited to foothill and mountain range lands at elevations up to about 6,500 feet	3–5	4–6

ning and ending with years of severe drought. This species, introduced into this country from Russia, is particularly well adapted to abandoned croplands throughout the State (fig. 3). In fact, of a total of 13 species tested by the Northern Rocky Mountain station in

extensive range plantings during the 1934–36 drought period, only crested wheatgrass and sweetclover gave good results. Nearly every species except crested wheatgrass tried concurrently at Havre by the Montana Agricultural Experiment Station was winter-killed, or died from drought or the combination of drought and dry freezing. With more favorable climatic conditions, recent plantings of crested wheatgrass have been even more generally successful.

Not only does crested wheatgrass withstand drought and low temperatures well but, as shown in figure 4, it competes successfully with weeds and can be established more readily than most other species so far tried. A long-lived bunchgrass that makes early and rapid growth in the spring, it becomes dormant during hot, dry summer

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FIGURE 3.—Crested wheatgrass drilled in strips on weedy, formerly plowed range land at the U. S. Range Livestock Experiment Station, Miles City, Mont.

periods and resumes growth when the soil moisture is replenished by fall rains. It grows best in cool weather if moisture is available. As it is a prolific seed producer, stands that start thinly often thicken up satisfactorily through natural reseeding. Seed currently sells for 11 to 15 cents per pound and is readily obtainable from most Montana seed dealers.

New growth of crested wheatgrass is palatable to all classes of livestock and is especially valuable as green forage in a calving or lambing pasture, since it may be grazed a week or two earlier than forage of most native species. Cattle graze mature stems in the fall, along with the green basal leaves that are produced after late summer or early fall rains. If ungrazed until seeds begin to form, however, it becomes coarse, stemmy, and rather unpalatable. Spring grazing stimulates leaf production. Just how heavily it can be grazed each year without impairing maximum yields has not as yet been determined. Crested wheatgrass hay cut at flowering stage is said to equal in quality most types of native-grass hay.

The Fairway strain of crested wheatgrass, developed in Canada from the standard strain, differs in that it is somewhat smaller, with finer stems and leaves. Preliminary results from recent studies con-

ducted by the Montana Agricultural Experiment Station indicate that at certain stages of development the Fairway strain is lower in lignin content and therefore more readily digested. In a feeding trial by the same station, yearling steers gained more weight on Fairway than on standard crested wheatgrass hay, both cut at the same growth stage. The seed of the standard strain has usually been a little cheaper and has been more widely sown in Montana.

Unless conditions particularly favor growth, seedlings of both strains of crested wheatgrass develop slowly the first season and may easily be overlooked in a casual examination. In dry seasons,

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FIGURE 4.—Barely a trace of the previous thick stand of Russian-thistle remains on this gravelly, windswept, formerly plowed range, reseeded with crested wheatgrass in October 1934.

the seed may not germinate. Plantings that later produced good stands have frequently been reported as failures the first season. It is well, therefore, to reserve judgment of success at least until the second growing season.

SMOOTH BROME

For best growth, smooth brome requires soil moisture to the degree ordinarily obtainable on mountain range lands at elevations greater than 5,000 feet, in the lower foothills and western edge of the plains where average annual precipitation is more than 15 inches, and in swales and depressions farther east. During dry seasons it has been much more difficult to establish than crested wheatgrass. Once a stand is obtained, smooth brome endures drought and low temperatures remarkably well. While it is therefore a questionable choice in many localities, smooth brome is one of the outstanding species for use where soil moisture is sufficient. It can be grown on sandy soils, though best results are obtained on fertile clay and loams. Seed can ordinarily be obtained for about 15 cents per pound from most dealers.

Smooth brome is a vigorous, long-lived forage plant of high grazing value that under favorable conditions sends out many underground rootstocks to form a dense sod. But the Parkland strain (fig. 5), another Canadian development, has a tendency to remain in bunches. Stands of this strain are thus less apt to become sod-bound.

YELLOW SWEETCLOVER

In a series of range trials on formerly plowed range lands under a wide variety of conditions, yellow sweetclover has shown up as the second most promising species. It grows throughout Montana, even

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FIGURE 5.—The Parkland strain of smooth brome produced an abundance of excellent forage on a weedy, formerly plowed range area near Miles City.

on depleted mountain range lands and the raw subsoils of highway borrow pits. This species is of limited value as range forage after midsummer, and should be grazed during the growing season before the stems become coarse. It commonly makes a fair showing the first season and becomes vigorous the second, but both tops and roots of the original plants then die. It is therefore a good choice for a range mixture, particularly when seeded with grasses that require two or three seasons to reach maximum production. Seed may be obtained currently for less than 10 cents per pound from most seed dealers.

Sweetclover shares with other legumes the distinction of being a good soil improver, a quality of considerable importance in restoring formerly plowed ranges. It is, of course, objectionable in wheatfields and on certain other cultivated lands, but deserves more consideration for range lands that are low in nitrogen and organic matter. Some ranchers object to its use in a mixture because it develops more rapidly than grasses sown at the same time, competing with them

for soil moisture to the degree that the grasses do not attain their normal size as quickly as in pure stands. Those advocating sweetclover point out that it serves as a nurse crop for the grasses and produces greater yields of forage the first year or two. The evidence is not yet sufficient to settle the argument either way.

There are annual as well as biennial sweetclovers of both white and yellow sorts, but the biennial types are considered best adapted to northern States. Biennial yellow sweetclover has been the most popular in Montana, particularly for use on formerly plowed range lands. It is more tolerant of adverse climatic conditions than the white kind, and its lower, more prostrate habit of growth insures development of some flower heads so close to the ground that they may escape grazing and serve to reseed naturally. Yellow sweetclover produces abundant seed and can usually regenerate itself for a number of years, but perennial grasses may then gradually crowd it out. Having a deep root system, it remains green after more shallow-rooted species have dried and become dormant. This characteristic was especially notable during the 1934 and 1936 droughts.

Some prejudice against the use of sweetclover has arisen because it occasionally causes bloat in cattle and sheep. A survey by the Montana Agricultural Experiment Station showed, however, that only 5 out of 131 growers reporting had lost livestock from bloat on sweetclover pastures, and recent studies indicate little danger of loss where sweetclover occurs in mixture with grasses.

SPECIES ADAPTED EXCLUSIVELY TO THE PLAINS

Besides the three forage plants already discussed, a few other species have given promising results on formerly plowed or depleted range lands of the plains.

Ladak alfalfa, seeded during drought years on the heavier soils of the Yellowstone River Valley, has made a creditable showing, particularly in swales. It is a deep-rooted legume, a splendid soil builder, and under favorable conditions produces an abundance of highly palatable forage; but data as to how well it holds up under grazing conditions are quite meager. It may be sown more extensively on plains where the average annual precipitation exceeds about 15 inches, as well as on intermountain valley and foothill ranges. The difficulty often experienced in obtaining a satisfactory stand of this species on the lighter, well-drained soils of the benchlands, along with the relatively high cost of the seed, makes it a questionable choice of such areas. The danger that Ladak alfalfa may cause bloat in livestock also should be fully recognized. For the lower, moister sites, however, there are many points in favor of sowing this highly palatable legume in range-forage mixtures.

Bluestem wheatgrass, or "western wheatgrass" as it is more commonly called, especially by commercial seed dealers, grows widely on the plains. On the formerly plowed range lands of eastern Montana it is one of the first of the native grasses to occupy slight depressions where runoff waters accumulate. Bluestem wheatgrass is a long-lived perennial that produces spreading, underground rootstocks, forming an open sod. It is valued highly as forage and, except for the fact that it is more difficult to establish than some other species, would doubtless be more generally favored.

Blue grama is one of the most valuable and widely distributed native grasses on the plains ranges of eastern Montana. It is a hardy, drought-resistant perennial with spreading, fibrous roots, forming a sod if conditions are favorable. Most of its growth is made during the late spring and early summer. Blue grama is generally rated a choice forage species for all classes of livestock. But there has been some difficulty in obtaining satisfactory stands of blue grama on formerly plowed plains ranges. Blue grama has very small seed, which must be shallow-planted; probably for this reason it is more liable to suffer from a brief period of adverse weather than larger seeded species. Being fluffy, the seed is difficult to handle, but it becomes easier to sow if put through a hammer mill to remove the seed coat and break up the florets. Without question, blue grama is adapted to most plains ranges, and it should be used more generally as locally grown seed becomes more readily available on the market.

Since no single species possesses all of the qualities of an ideal range-forage plant, a mixture is often preferable to a pure stand. Then, too, the species best suited to the site is in this way more likely to be sown. Frequently mixtures produce a greater volume of palatable forage than do pure stands. For reseeding formerly plowed or depleted range lands of the plains, a mixture may well include 4 parts (by weight) of crested wheatgrass and 1 part of yellow sweetclover. In the swales and places where runoff waters accumulate or in localities where average annual precipitation exceeds about 15 inches possible substitutions in the foregoing mixture are 1 part of Ladak alfalfa for the yellow sweetclover, and 2 parts of smooth brome or bluestem wheatgrass for half of the crested wheatgrass.

SPECIES ADAPTED EXCLUSIVELY TO MOUNTAIN, FOOTHILL, AND VALLEY RANGES

Besides crested wheatgrass, smooth brome, and sweetclover, already discussed, species of value for reseeding depleted mountain, foothill, or intermountain-valley range lands include tall oatgrass, mountain brome, orchard grass, Indian ricegrass, Canada bluegrass, and timothy. Among other species that are doing well in nursery and small field tests are bearded bluebunch wheatgrass, beardless bluebunch wheatgrass, thickspike wheatgrass, Russian wild-rye, *Agropyron intermedium*, meadow brome, and big bluegrass. Some of these should prove especially valuable on certain mountain and foothill range lands, but further research is needed before they can be recommended. Moreover, it may not be possible at present to obtain seed of these species at moderate prices, since they have not as yet been used extensively for range reseeding.

Tall oatgrass is particularly well adapted to the mountain ranges where there is usually more soil moisture than on the plains. At elevations greater than about 5,000 feet, this tall-growing bunchgrass has sometimes equaled or even surpassed crested wheatgrass in forage yield. Sowing a mixture of these two species on a depleted range area on the Lewis and Clark National Forest produced a dominant stand of tall oatgrass in the bottom of a draw (fig. 6), but on nearby, well-drained slopes, crested wheatgrass was dominant. Much of the tall oatgrass seed is produced in Oregon and Washington; if unobtainable locally it can be purchased from seed dealers in those

States. A minor objection to tall oatgrass is that the fluffy and awned seed, tending to mat together, is difficult to sow. This trouble can be partially overcome by sowing it in mixture with two or more parts of seed of some other species or combination of species, or better still, by removing the awns in a hammer mill. As figure 6 shows, tall oatgrass can produce a large volume of forage.

Mountain brome is a perennial bunchgrass well adapted to depleted mountain ranges, particularly at elevations greater than 5,000 feet. Although relatively short-lived, it produces both forage and seed in fairly large volume. Including mountain brome in a mixture may often be advantageous, especially on open woodland or timber ranges where mineral soil is exposed. Seed can be obtained from most seed dealers.

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FIGURE 6.—Broadcast seeding of tall oatgrass produced this stand on depleted mountain range land. Lewis and Clark National Forest.

Orchard grass, a highly palatable bunchgrass producing a good volume of leafy forage, offers considerable promise of success on depleted mountain range where better-than-average moisture conditions prevail, such as mountain parks and meadows or mountain slopes where the average annual precipitation exceeds 16 inches. It is growing very well in partial shade on numerous reseeded spots along the Ruby River in southwestern Montana at elevations up to 6,200 feet. There should be no difficulty in obtaining seed.

Indian ricegrass is a moderately palatable bunchgrass. Best adapted to the lighter, well-drained soils of both foothills and mountain slopes, this plant occurs naturally on rather severe, windswept sites, particularly on sunny exposures. Perhaps because of its hard, somewhat impervious coat or its tendency to dormancy following the ripening period, the seed often lies in the ground until the second season before germinating. Seed of Indian ricegrass may be somewhat difficult to obtain.

Canada bluegrass is often found growing on the range lands of the foothills and lower mountain slopes. Under favorable conditions it produces vigorous, spreading, underground rootstocks and forms a sod. It is, however, rather difficult to establish; there is some question as to its persistence after the first few seasons; also seed may not be easy to obtain in quantity. For these reasons, the extensive use of Canada bluegrass is not recommended at present.

Timothy is a hardy perennial grass producing an abundance of palatable forage on moist sites. Being most successful in a cool, humid climate, it is well suited to the mountains at lower and medium elevations and should not be used on hot, dry sites. It can frequently be used to advantage in a mixture for reseeding depleted mountain meadows and parks. Seed can be obtained at a moderate price from most dealers.

A satisfactory mixture for seeding depleted mountain, foothill, or intermountain-valley range lands that are relatively moist is crested wheatgrass, yellow sweetclover or Ladak alfalfa, and one of the following—smooth brome, mountain brome, tall oatgrass, orchardgrass, bluestem wheatgrass, or timothy. This mixture may be varied by using different combinations of the species mentioned. In the drier foothills and intermountain valleys, the recommended plains mixture consisting of 4 parts of crested wheatgrass and 1 part of yellow sweetclover may be used. At higher elevations or on more moist sites, the proportion of crested wheatgrass should be reduced, one or more of the other grasses added, and Ladak alfalfa possibly substituted for yellow sweetclover.

WHEN TO SOW

The best time to sow varies with species used, locality, and cultural method. Late fall is ordinarily superior to spring sowing for all grasses discussed except blue grama, which is best sown in midspring. Late fall is better, in particular, for plantings made without seedbed preparation on formerly plowed ranges, and for all plantings made on depleted range in the lower, drier foothills. On a well-prepared seedbed, however, early spring plantings have given best results, according to Montana Agricultural Experiment Station reports of tests at its Havre and Moccasin branch stations.

Differences resulting from fall or spring sowing tend to become less marked as available moisture increases. Thus, if rainfall is well distributed through the growing season, as is rather characteristic of mountain climate, early spring may be a better time to sow than late fall. But this general rule does not hold good in every case; there was little difference in the results of fall and spring plantings in one series of tests at an elevation of 6,200 feet.

Late fall sowing should be done somewhat in advance of the time the ground usually freezes, but not so early that fall germination is likely to occur. Spring sowing should be started as early as possible, so that the seedlings will be past the tender early-season stage of development before late spring or early summer drought. Where fall rains are plentiful, early fall (September or early October) is a desirable sowing time. Throughout most of the plains and foothill ranges, however, the chance that heavy seedling losses may be caused by dry fall weather makes early fall planting hazardous unless the soil contains ample moisture.

Although most legumes are best seeded in the spring, both Ladak alfalfa and yellow sweetclover have been successfully planted in the fall. However, a range mixture including these legumes and one or more grasses should be sown at the time recommended for the grasses.

HOW TO SOW

SEEDBED PREPARATION

If a range area that is to be reseeded supports a heavy stand of cheatgrass (fig. 7), some sort of treatment to reduce competition is advisable. Disking or spring-tooth harrowing is recommended, except on slopes so steep that severe erosion would be likely to result.

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FIGURE 7.—Hundreds of fields and thousands of acres of formerly plowed range are covered by such thick stands of cheatgrass. Disking or other means of reducing competition before reseeding greatly increases the chances of success.

The best time for such seedbed preparation is while the soil remains moist from fall rains that have caused the cheatgrass brome seed to germinate. For treatment of rocky or brushy range lands, a heavy disk harrow with notched or cut-out disks about 24 inches in diameter has proved effective on slopes up to 40 percent. On steeper slopes, contour furrows at slope intervals of 8 to 12 feet may be made with a reversible (sidehill) plow and a heavy horse or a team. Furrows of this sort make excellent seedbeds. Although somewhat expensive, contour plowing is justified also as a measure for control of severe erosion on depleted slopes. Plowing all the ground is considered impractical as a method of seedbed preparation on most ranges, because of its cost.

Where considerable litter and duff are on the ground, as for example where stands of Douglas-fir or lodgepole pine have been cleared to increase the range forage, special measures to get the seed into close contact with the mineral soil will greatly improve the chances

of success. Unless the litter is too thick, soil scarification with a spring-tooth harrow, a cut-out disk, or other similar means is desirable. Very heavy litter may require raking and disposal.

Cultivation prior to sowing, insofar as it is effective in conserving soil moisture by reducing competition, may be helpful, but it does not always have beneficial results. Certain objectionable results may largely overbalance any beneficial effects. It may only succeed in turning a firm seedbed into a surface so loose that soil and seeds may blow away. Furthermore, seedbed preparation may destroy desirable native grasses that have already become established and may encourage sheet and gully erosion. Russian-thistle and other weeds are helpful in arresting wind erosion, in catching snow, and in preventing formation of a hard crust that would hinder emergence of the seedlings. Some shading of the new plants may also be of advantage. One test in eastern Montana showed that while surface temperatures of bare soil frequently exceeded 120° F.—higher than young grass seedlings can long endure—soil in the shade of Russian-thistle was 12° to 44° F. cooler. Finally, much range land is not sufficiently productive to justify the high cost of cultivation.

Satisfactory stands of grass may often be obtained without seed bed preparation. Many formerly plowed range lands have been successfully sown by drilling the seed on an unprepared seedbed bearing Russian-thistle and other late-developing annual weeds. Where the weeds are so thick that they choke the drill, it may be necessary to use a drag and to rake the old growth before continuing the work. Burning of stubble to make seeding easier is not recommended; this organic matter is important in maintaining and building up the soil and should not be destroyed. If the heavy weed growth clogs the drills, this can be largely avoided by the use of modern heavy drills with large disks. In numerous instances seedbed preparation has proved unnecessary on raw or freshly disturbed soil or on intense burns. On a recently logged national-forest area in southwestern Montana, for example, burned areas and skid roads were successfully broadcast-sown in both spring and fall, without preparing the seedbed or covering the seed.

SOWING

A grain drill is the best means of sowing if the surface and topography are suitable (fig. 8). Use of a drill insures more uniform distribution and covering of the seed, so that a smaller quantity of seed per acre is needed. Where it is necessary to cut through weedy annuals before the seed can be placed in the soil, the furrow drill has a decided advantage. If interference by weeds does not affect the choice, the disk drill appears to be slightly superior for spring and the furrow drill for fall sowings.

In planting most grasses special grass-seed attachments for the drill are unnecessary. Even very small-seeded species have been planted with an ordinary grain drill, the seed first being mixed with from 3 to 5 parts of sawdust. Blue grama seed may be sown in this way, though results are more satisfactory if the seed coats are first removed in a hammer mill. In drilling formerly plowed or depleted range lands, every other drill should be stopped, so that the seed rows will be approximately 12 instead of 6 inches apart. This spacing is close

enough to produce a closed stand on favorable sites, and the individual plants will generally be more vigorous. Furthermore, the wider spacing makes it possible to use less seed per acre. At Miles City, an experiment with 6-, 12-, and 30-inch spacings between drill rows showed that after the stand was well established total yields were about the same for all spacings. Mortality from drought was greatest for the 6-inch spacing and least for the 30-inch spacing.

Where site conditions forbid use of a grain drill, simpler means of sowing are satisfactory. A "cyclone" hand seeder (fig. 9) often serves very well on skid roads, ditchbanks, road shoulders, contour furrows, sheep bedgrounds, and similar sites, or even on larger areas where rubbish or brush has been burned. A few ranchers make a

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FIGURE 8.—A 10-foot grain drill being used on an unprepared seedbed to sow grass on a formerly plowed foothill range area.

practice of scattering seed by hand from horseback in the early spring and late fall on small, freshly disturbed spots, such as those near trails on mountain range lands where the forage cover is thin but soil and moisture conditions are favorable. The increased forage from plants thus established has in a number of instances more than repaid the slight effort and expense involved.

Where conventional methods seem impracticable, ingenuity will devise ways to carry on reseeding work at a reasonable cost, benefits considered. For example, an old-fashioned hand corn planter has been modified and successfully used to plant grass seed on very steep and rocky slopes of small extent. Hay containing ripe grass seed has been scattered over the ground with good results; this method protects the young seedlings from drying winds and the hot sun and accordingly is of particular value for small, bare areas on sunny, windswept exposures. Burlap sacks, filled with soil in which a handful of seed has been sprinkled, may sometimes be used as check dams in shallow gullies on range lands where slopes are gentle. These

serve both to start grass growth and to control erosion. On the Beaverhead National Forest, in southwestern Montana, a start has been made in the healing of some rather deep gullies through hand-sowing of grass where tops of trees were placed to lessen run-off.

COVERING THE SEED

If a drill is used in sowing, the machine covers the seed automatically. If the seed is broadcast some special means should usually be employed to cover it, such as a disk, spike-tooth, or spring-tooth harrow, a brush drag, trampling in with sheep, or, on very small areas, raking by hand. Especially after spring plantings on disturbed surfaces, harrowing or brush dragging helps to insure success. In fall

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FIGURE 9.—Mountainous sites such as this skid road on a western Montana logged area are conveniently sown with a "cyclone" hand seeder.

plantings, where the ground has been harrowed before the seed is broadcast, freezing and thawing of the soil during the winter will often cover the seed adequately. This is true also on contour furrows, newly constructed road shoulders, and other surfaces where loose mineral soil is exposed. As previously mentioned, satisfactory stands of grass have sometimes been obtained on burns and loose surfaces by broadcasting seed without any attempt to cover it, but in most cases covering the seed is well worth the effort.

DEPTH TO SOW

Three-fourths inch to 1 inch is considered the most favorable depth for the seed of most range grasses. For very small-seeded species, such as blue grama and Canada bluegrass, a depth of less than one-half inch is better. While very shallow plantings often obtain the best germination, the seedlings that result are usually subject to high mortality from rapid drying out of the surface soil. The proportion of seedlings that emerge decreases materially as depth of cover is increased. If a furrow drill is used, care must be taken not to cover

the seed too deeply. The furrows may become filled with soil washed in by dashing rains or weathering during the winter, and seed originally covered to a depth of 1 inch must then send up shoots through 2 inches or more of soil in the spring, so that seedling emergence is poor.

RATE TO SOW

The rate of sowing that will give best results on a given site depends upon the species used, the purity and viability of the seed, and the method of sowing. Species having large seeds, such as mountain brome, obviously require a greater quantity of seed per acre than smaller-seeded species, such as crested wheatgrass. Again, a greater quantity of seed is required if the quality and germination percentage are low. Less seed is used in a grain drill than by other sowing methods. With crested wheatgrass, for example, from 3 to 5 pounds of seed per acre, drilled in rows 12 inches apart, is sufficient to obtain good stands of grass on depleted or formerly plowed range lands. There is considerable evidence that sowing more than 5 pounds of seed per acre on such areas will not materially increase the stand of this species. Indeed, 2 to 3 pounds per acre would be sufficient under optimum conditions if the seed could be made to feed through the drill steadily at such low rates. When crested wheatgrass is broadcast with hand seeders, which distribute the seed less uniformly than a drill and cannot control the depth of sowing, 4 to 6 pounds of seed per acre is recommended (table 1).

Rates of seeding shown in table 1 have been calculated as sufficient to produce satisfactory stands when seed of high purity and germinability is used on depleted or formerly plowed range lands. These individual rates can also be used as guides for determining the amount of mixed seed to sow. For example, the rate for drilling a mixture of equal parts crested and bluestem wheatgrass would be half the individual rate for each, or 4½ to 6½ pounds for the mixture per acre. The seed should be thoroughly mixed before sowing.

MANAGEMENT OF RESEEDED RANGE LANDS

While good stands of grass have been obtained on reseeded areas that were moderately grazed even in the first growing season, better and more vigorous stands may be expected if livestock are excluded during the periods of most rapid growth for one or two seasons after the plantings are made. It is particularly hazardous to graze a new stand of grass during wet weather when the ground is muddy, as the young plants are likely to be pulled out or damaged by close grazing and trampling.

Complete protection from grazing, however, may not be essential in all cases (fig. 10). An interesting example is the Lindlief ranch in Silver Bow County, on which a formerly plowed area was reseeded in 1934 and so fenced that cattle were admitted to one end each season between September and the latter part of April, and excluded from the other end. Some years later both grazed and ungrazed parts had very good stands of grass. Here, it is true, grazing had not been permitted during most of the actual growing season, but on the Line ranch in Stillwater County, a good stand of crested wheatgrass was established on abandoned cropland despite moderate graz-

ing throughout the growing season. Equally good results with moderate grazing by cattle during most of the growing season were obtained on unplowed but depleted range lands in Lewis and Clark, Powder River, and Madison Counties, as well as on cut-over timberlands in Ravalli County. It should be emphasized that early grazing of young stands cannot be recommended without qualification, on the basis of these few cases. The practice is likely to result in damage or destruction to the stand and should be used cautiously and only when other arrangements to carry the livestock cannot be made.

Protection from grazing can sometimes be provided by a shift in management plans whereby grazing on the entire allotment or pasture containing a reseeded area is deferred through the growing season.

FIGURE 10.—Crested wheatgrass at 6,200 feet elevation on depleted Beaverhead National Forest range that was broadcast-seeded in May 1938 after preparation with a heavy cut-out disk and has since been grazed moderately by cattle. Photograph taken in June 1940.

If this is not feasible, it may be advisable to fence the reseeded area, taking advantage of as much existing fence as possible in order to reduce the outlay. Electric fences can furnish necessary temporary protection at reasonable expense. The cost of protection lies chiefly in the fencing cost, since the loss of existing forage for a season or two is generally of minor consequence where forage production is low enough to warrant reseeding. In many instances, moreover, some of the forage made available by reseeding may be grazed in the fall of even the first growing season with little damage. If the initial stand is thin, exclusion of livestock until the time of seed shattering for one or two additional seasons will encourage natural reseeding and may save the expense of a second sowing.

Management of the reseeded range after the stand of grass is well established should not differ greatly from that of native grass ranges.

A recognized principle of range management is that greatest sustained yields are generally realized under moderate or conservative grazing use. Well-established stands of crested wheatgrass may be grazed closely enough in the spring to check accumulation of seedstalks. Where such grazing is practiced, it is essential to remove the livestock before hot, dry summer weather sets in, so that the grass can recover sufficiently to maintain its vigor. Reseeded range lands can be grazed to advantage in the fall and early winter, as well as in the spring, since the new growth that follows early fall rains is readily taken, along with some old stems from the previous spring.

SUMMARY OF COSTS AND RETURNS

Costs should be weighed against all probable benefits before extensive reseeding operations are undertaken. In such an analysis, the long-time viewpoint should be taken, since reseeding is an investment that brings both direct and indirect benefits spread over a period of years. Taxes, interest, and carrying charges on a given piece of range land may be expected to remain about the same, whether or not it is reseeded. The practicability of reseeding a specific area depends largely, then, upon the balance between total cost of the operation and such expected returns as increased quality and quantity of forage, conservation of the soil, and protection to irrigation ditches and other property below, through reduction of runoff and erosion.

SEED COSTS

The cost of the seed varies with supply and demand from year to year, the species used, and the rate of sowing. Seed of the more popular species used in artificial revegetation is now stocked by many of the dealers. The purity and germination percent of the seed should be stated on a tag attached to each bag of commercial seed. It pays to use good seed.

Because crested wheatgrass is used more widely than any other species for regrassing depleted or formerly plowed range lands in Montana, it will be used as the example in estimating seed cost per acre. Locally grown seed of this species can now be purchased for 11 to 15 cents a pound. Thus, at the recommended rate of sowing, the cost of seed per acre would be 33 to 75 cents if drilled and 44 to 90 cents if broadcast. Other common species vary somewhat in cost, but in general average about the same as crested wheatgrass.

Should seed costs again approach the level of a few years ago—50 to 75 cents per pound—the net cash outlay for seed can be reduced in various ways, though at some sacrifice of time. Seed may be homegrown for range sowing by planting the desired species on spots best suited to seed production. To obtain greater yields of well-filled seed, the spacing between drill rows should be 24 to 30 inches. Another means of compensating for high seed costs is to sow in strips lying at right angles to the direction of prevailing winds and separated by unseeded strips a rod or more wide. An alternative is continuous drilling, with enough of the drill feeds stopped so that the planted rows will be 30 to 36 inches apart. Under favorable conditions, some species will spread rapidly between seeded rows or strips through natural reseeding (fig. 11). Except when seed is expensive,

however, planting in strips is generally questionable because of the delay in obtaining a satisfactory stand of grass on the entire area.

LABOR AND MACHINERY COSTS

In normal times the cost of labor and machinery for reseeding is affected mainly by the sowing method and the size and location of the area. Where a 10-foot grain drill is used on a conveniently situated area 10 acres or more in size and seedbed preparation is unnecessary, the cost of labor and machinery per acre seeded should not exceed 40 cents; one large ranch operator in central Montana contracts his plantings at this figure. Seedbed preparation may cost 30 cents or

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FIGURE 11.—An abundance of volunteer crested wheatgrass seedlings between the original 30-inch drill rows on a formerly plowed range area near Miles City.

more per acre, depending upon whether the area is harrowed, disked, or contour-plowed.

Broadcasting with a hand seeder on depleted range areas that are easily accessible, together with harrowing to cover the seed, ordinarily costs about 40 to 45 cents per acre. Hand seeders are obtainable from most seed or implement dealers for approximately $2.50. The cost of labor for the sowing operation alone, on reasonably large and compact areas, is about 10 to 15 cents per acre.

For broadcast seeding of small, discontinuous strips of depleted mountain range lands, the cost may be 50 to 100 percent higher. Recent plantings made with Civilian Conservation Corps labor on the Bitterroot National Forest in western Montana furnish a good basis for an estimate. Only the skid roads and burns on a 2,000-acre logged area, part of which is shown in figure 12, were broadcast-sown with ordinary hand seeders. To seed about 175 acres, net, required 28 man-days. Thus, at $1.50 a day for each C. C. C. worker, the total cost for labor was 24 cents per acre seeded.

The use of labor and machinery does not necessarily involve a direct cash outlay, as the reseeding operation can often be performed with labor and equipment that is available and otherwise unoccupied.

TOTAL COST

A summary of the estimated costs of reseeding depleted or formerly plowed range lands to crested wheatgrass by the methods previously discussed appears in table 2. Generally the largest item of expense is the cost of the seed, and the totals may differ slightly from those given if other common forage species are sown. These estimates apply to readily accessible areas of 10 or more acres reseeded with ranch

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FIGURE 12.—Broadcast seeding of this logged-over area in western Montana showed promise, within a few months, of reducing erosion and increasing the summer forage urgently needed by small nearby ranch units. Bitterroot National Forest.

equipment and labor. They include neither the clearing of weeds that is occasionally required, nor fencing, which has been discussed in the section on management. The cost of obtaining a good stand of grass may sometimes be twice as great as that shown in table 2,

TABLE 2.—*Estimated cost per acre for reseeding crested wheatgrass on formerly plowed or depleted range lands* [1]

Item	Drilling	Broadcasting without covering seed	Broadcasting and harrowing
Seed	$0.33–$0.75	$0.44–$0.90	$0.44–$0.90
Labor and machinery	.40– .40	.10– .15	.40– .45
Total	.73– 1.15	.54– 1.05	.84– 1.35

[1] Fencing is not included.

if failure caused by grasshoppers or unfavorable weather conditions makes it necessary to sow the area again.

RETURNS FROM RESEEDING

The most direct benefit to accrue from reseeding is increased production of palatable forage. This increase is due partly to a greater total yield and partly to the substitution of palatable grasses for

FIGURE 13.—Cheatgrass brome on formerly plowed range land can sometimes be choked out by reseeding to crested wheatgrass. *A*, A cheatgrass area in southeastern Montana as it appeared in 1935, after being partially drilled to crested wheatgrass in the dry fall of 1934; *B*, portion of the same area in 1940, crested wheatgrass replacing most of the cheatgrass.

weeds and other plants of low value (fig. 13). Four seasons after parts of three typical depleted mountain ranges and five formerly plowed plains and foothill ranges were reseeded to crested wheatgrass their average grazing capacity was 285 percent of that of the unseeded portions, as shown by comparisons of clipped yields. At the same time, the average yield per acre of Russian-thistle and other weeds was reduced from 683 to 286 pounds, while cheatgrass brome was reduced from 429 to only 32 pounds per acre. Such results may

reasonably be expected from reseeding numerous other weed-infested ranges in a low state of production—ranges formerly plowed or otherwise misused to the extent that the valuable perennial grasses have been largely or completely destroyed.

These sowings were made without seedbed preparation, inexpensive methods being employed throughout. Yet, in spite of the added handicap of drought, average grazing capacity was increased so much by reseeding that nearly three animals could be grazed where only one was grazed before.

Observations and tests indicate that the grazing capacity of reseeded range may equal or surpass that of good natural range. Furthermore, crested wheatgrass range can usually be grazed a week or two earlier in the spring than native range. At Miles City a 3-year comparison of grazing on crested wheatgrass and on adjacent native ranges somewhat below average because of previous heavy use showed that gains per acre, as made by yearling heifers and steers, were more than twice as great on the reseeded range as on the native range. Quality of the forage, however, as indicated by gains per animal, appeared to be higher for the native grasses. These findings were confirmed by a series of dry-land-pasture studies conducted by the Montana Agricultural Experiment Station at the Judith Basin Branch, which showed that crested wheatgrass was grazable for a longer season, beginning about 2 to 3 weeks earlier in the spring, had a higher capacity, and produced more beef per acre than either smooth brome or native-grass pasture.

Besides marked increases in production, the regrassing of range lands offers certain other rewards, some of which may be of even greater value than the forage itself. Reseeding tends to stabilize the livestock industry by providing a more dependable type of forage. It helps to conserve both soil and water by reducing run-off and erosion. It increases esthetic values by covering up the unsightly evidence of past mistakes, particularly in the case of "bottom up" lands. Finally, the range manager who in this way increases the productiveness of depleted ranges wins the considerable satisfaction of knowing that he has done his part as a good steward of the land.

COMMON AND BOTANICAL NAMES OF SPECIES MENTIONED

Alfalfa, Ladak	*Medicago sativa*×*falcata.*
Bluegrass, big	*Poa ampla.*
Bluegrass, Canada	*P. compressa.*
Brome, cheatgrass (downy brome, downy chess)	*Bromus tectorum.*
Brome, meadow	*B. erectus.*
Brome, mountain	*B. carinatus* (syns. *B. marginatus; B. polyanthus*, etc.).
Brome, smooth	*B. inermis.*
Cheatgrass (*see* Brome, cheatgrass)	
Chess, downy (*see* Brome, cheatgrass)	
Douglas-fir	*Pseudotsuga taxifolia.*
Fescue, Idaho	*Festuca idahoensis.*
Grama, blue	*Bouteloua gracilis.*
Oatgrass, tall	*Arrhenatherum elatius.*
Orchard grass	*Dactylis glomerata.*
Pine, lodgepole	*Pinus contorta latifolia.*
Ricegrass, Indian	*Oryzopsis hymenoides.*
Russian-thistle, tumbling	*Salsola kali tenuifolia.*
Sagebrush	*Artemisia* spp.

Saltgrass, inland	*Distichlis stricta.*
Sweetclover, white	*Melilotus alba.*
Sweetclover, yellow	*M. officinalis.*
Timothy	*Phleum pratense.*
Wheatgrass, bearded bluebunch	*Agropyron spicatum.*
Wheatgrass, beardless bluebunch	*A. inerme.*
Wheatgrass, bluestem (western wheatgrass)	*A. smithii.*
Wheatgrass, crested	*A. cristatum.*
Wheatgrass, western (*See* Wheatgrass, bluestem)	
Wild-rye, Russian	*Elymus junceus.*

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